Working Paper
in Economics and
Development Studies

Department of Economics
Padjadjaran University

No. 200902

Assessing Monetary Policy Efficiency in the ASEAN-5 Countries

Arief Ramayandi

Center for Economics and
Development Studies
(CEDS)
Padjadjaran University

March, 2009

Center for Economics and Development Studies,
Department of Economics, Padjadjaran University
Jalan Cimandiri no. 6, Bandung, Indonesia.
Phone/Fax: +62-22-4204510
http://www.lp3e-unpad.org

For more titles on this series, visit:
http://econpapers.repec.org/paper/unpwpaper/

Assessing Monetary Policy Efficiency in the ASEAN-5 Countries

Arief Ramayandi
CEDS - Padjadjaran University
Indonesia

2009

Abstract

This paper investigates whether or not monetary policy has been conducted efficiently in five selected ASEAN economies. It derives a utility-consistent social loss function, as a metric for welfare, to assess monetary policy efficiency in a small open economy model. An optimal monetary policy that minimises the social loss function is solved using information on structural parameters estimated for a model that represents each of the selected ASEAN-5 countries. The results are largely consistent with common wisdom in the literature, where policies based on credible commitment give the best welfare outcome. The paper further examines the welfare implications of the currently adopted simple monetary policy feedback rule for each of the sample economies. This exercise points out that there is room for improving the performance of monetary policy in each country, and it should be explored further. It also suggests the possibility that monetary authorities in the sample countries may be optimising over an objective function that differ from the social welfare function derived in the paper.

JEL classifications: E52, E58, C61, F41
Keywords: ASEAN, monetary policy, optimal policy rules, social welfare function.

Contents

1 Introduction **3**

2 Utility-Based Welfare Criterion **4**

2.1 The second-order approximation to the utility function 5

2.1.1 The consumption part 5

2.1.2 The disutility out of working 6

2.2 The utility-based welfare criterion 7

3 Measuring Welfare Under Optimal Monetary Policy **8**

3.1 Optimal policy under precommitment 9

3.2 Optimal policy under discretion 11

4 Monetary Policy in the ASEAN-5: Commitment vs. Discretion **13**

4.1 Setting up the problem 13

4.2 Results: Commitment vs. discretion 14

5 Welfare Under the Current State of Policy Feedback Rule **16**

5.1 Measuring welfare under the current feedback rule 17

5.2 Results 18

6 Room for Improvement? **19**

6.1 Example 1: Altering all policy parameters 20

6.2 Example 2: Keeping the degree of interest persistence 21

6.3 A note on the examples 22

7 Concluding Remarks **23**

1 Introduction

Monetary policy is a key instrument for stabilising short-run fluctuations in an economy. The conduct of monetary policy itself, however, is recognised to have implications towards the state of social welfare. The performance of monetary policy is deemed as efficient or optimal if it minimises the aggregate social loss that has to be paid by economic agents in general. The Barro and Gordon (1983) type of ad-hoc aggregate loss function and its variants have been extensively used in the monetary policy literature as an objective to be minimised when identifying an optimal policy. This ad-hoc aggregate loss function commonly consists of arguments on variations in inflation and the output gap.

Significant efforts in analysing efficient monetary policy have since grown in the literature. This is done by focusing the analysis on how to deliver monetary policy that minimises the variability of both output and inflation. De Brouwer and O'Regan (1997), Fuhrer (1997) and Cecchetti et al. (2006), for example, construct an output–inflation variability frontier that represents the inflation/output-gap trade-off as a basis to analyse monetary policy efficiency. Many others address the issue by ranking the welfare implications of different monetary policy setups, or even straightforwardly estimate an optimal monetary policy rule that optimises the aggregate loss function (see, for example, Rotemberg and Woodford, 1998; Clarida et al., 1999; Batini et al., 2003; Gali and Monacelli, 2005; Dennis and Soderstrom, 2006).

The analysis of optimal monetary policy is normally conducted by way of 'targeting rules',[1] which relies on an ad-hoc aggregate loss function (commonly interpreted as the policy maker's loss function). An optimal policy feedback rule is then defined as the policy instrument reaction function that minimises the loss. Another way to analyse monetary policy efficiency is through maximising the welfare impact of that policy. That is, a policy feedback rule is regarded as optimal if it maximises the aggregate utility of the representative economic agents. To this end, the aggregate loss function (commonly interpreted as the social loss function) is derived from the representative agent's utility function as discussed in Woodford (2003).

Although issues concerning the optimal conduct of monetary policy have been widely discussed in the literature, the discussions have mostly concentrated on the cases of advanced economies. Application of this analysis to developing economies is very limited. The objective of this paper is to contribute to the discussion on this issue by examining the cases of five developing ASEAN economies; namely Indonesia, Malaysia, the Philippines, Singapore and Thailand.

In analysing the above cases, this paper uses a linearised estimated small open economy model to represent the set of dynamic constraints facing each of the ASEAN-5 economies. Based on the 'deep' parameters that identify the representative agent's utility for these economies, the paper derives an aggregate social loss function that serves the role of calculating the metric of welfare. This welfare criterion is then used to analyse the fully optimal monetary policy environment for the economies under consideration.[2] The paper also looks at the welfare implications under the current monetary policy regime pursued by each of the ASEAN-5 economies. By comparing the resulting metric for welfare obtained under the fully optimal monetary policy environment and the one obtained under the current regime, this study shows that the conduct of monetary policy in all of the sample countries tends to be sub-optimal. By way of example, it is also shown that room for improving the welfare outcome of the policy exists, even when pursuing a simple policy

[1] See Svensson (1999) for a discussion on the distinction between instrument rules and targeting rules.

[2] The term "fully optimal" here refers to the situation where the resulting form of the optimal monetary policy feedback rule is not constrained to follow some certain (simple) functional forms. That is, the optimal feedback rule depends on all the state variables included in the system of dynamic constraints representing the economy.

feedback rule adopted by the current regime.

The rest of the paper is structured as follows. Section 2 derives the relevant utility-based welfare criterion to be used in analysing the optimality of monetary policy in the sample ASEAN-5 economies. Section 3 discusses the methodology applied to analyse the welfare implication of monetary policy under the fully optimal environment. Section 4 characterises the optimisation problem and analyses the welfare implication of conducting monetary policy optimally in each of the economies. Section 5 looks at the welfare implications of the current monetary policy regime, and discusses its optimality. Section 6 contemplates the possibility of improving the conduct of monetary policy for the sample countries. Section 7 concludes.

2 Utility-Based Welfare Criterion

The natural welfare criterion for the class of simple small open New Keynesian economy models considered in this paper is represented by the level of expected stream of utility of the representative household (HH) in the economy. That is,

$$E_t \sum_{t=0}^{\infty} \beta^t \left[U\left(C_t - H_t\right) - V\left(N_t\right)\right] \tag{1}$$

$U(\cdot)$ in equation (1) represents the HH utility out of consumption, which is assumed to be affected positively by the difference between current consumption decision and an exogenous external stock of habit formation within each period. The second term in equation (1), $V(N_t)$, represents the disutility generated out of working. This term is assumed to be positively affected by the number of hours working at each period (N_t).

The consumption part of the utility function above is assumed to take the following form:

$$U\left(\cdot\right)_t = \frac{\left(C_t - H_t\right)^{1-\sigma}}{1-\sigma} \tag{2}$$

Consumption (C_t) in (2) is an aggregation of an infinite number of differentiated goods (j) according to a Dixit-Stiglitz aggregator, $C_t = \left[\int_{j=0}^{1} C_t\left(j\right)^{\frac{\varepsilon-1}{\varepsilon}} \partial j\right]^{\frac{\varepsilon}{\varepsilon-1}}$.[3] The term σ is the inverse elasticity of inter-temporal substitution. The external stock of habit formation is assumed to be determined by past aggregate average consumption level ($H_t = hC_{t-1}$). This last variable (H_t) is taken as exogenous by each of the representative households at each period t, since each HH is assumed to be too small to affect the aggregate average consumption in the economy.

HH disutility out of working is defined as following:

$$V(N_t) = \frac{N_t^{1+\varphi}}{1+\varphi} \tag{3}$$

where $N_t = \int_{i=0}^{1} N_t\left(i\right) \partial i$ and φ is the inverse elasticity of labour supply.

[3] The functional form of this aggregator follows Dixit and Stiglitz (1977) and ε denotes the elasticity of substitution between differentiated goods of the same origin.

2.1 The second-order approximation to the utility function

Following common practice in deriving the utility-based welfare criterion,[4] the second-order approximation to (1) is derived by taking a second-order Taylor series expansion of the within period utility function $(U_t - V_t)$ evaluated at its steady state value. Due to its additively separable characteristic, the second-order approximation of this utility function can be conducted separately to each of the terms.

2.1.1 The consumption part

The second-order approximation to the consumption part of the within period utility is as follows:

$$U_t = \bar{U} + U_{\bar{C}}\left(C_t - \bar{C}\right) + \frac{1}{2}U_{\bar{C}\bar{C}}\left(C_t - \bar{C}\right)^2 + \mathcal{O}\left(\|\xi\|^3\right)$$

$\bar{U}$ and $\bar{C}$ are the steady state equilibrium values for U and C, respectively. $U_{\bar{C}}$ and $U_{\bar{C}\bar{C}}$ are the first and second derivative of U with respect to C, evaluated at $\bar{C}$; and $\mathcal{O}\left(\|\xi\|^3\right)$ summarises the higher order terms of the expansion, which is assumed to be very small. Given the particular functional form in equation (2), the above approximation can also be written as:

$$U_t = \bar{U} + (1-h)^{-\sigma}\bar{C}^{1-\sigma}c_t + \frac{1}{2}(1-h)^{-\sigma}\bar{C}^{1-\sigma}\left(1 - \frac{\sigma}{1-h}\right)c_t^2 + \mathcal{O}\left(\|\xi\|^3\right) \qquad (4)$$

where c_t denotes the log deviation of consumption from its steady state value.

In the small open economy model considered for the analysis here, the demand for domestic output (y) under the market clearing condition is positively affected by domestic consumption (c), foreign income (y^*) and real exchange rate (q); and negatively related to the shock to the law of one price (ψ). Demand for domestic output in this case is represented by the following output gap equation:

$$y_t = (1-\alpha)c_t + \alpha y_t^* + \frac{(2-\alpha)\alpha\eta}{1-\alpha}q_t - \frac{\alpha\eta}{1-\alpha}\psi_t \qquad (5)$$

The real exchange rate in equation (5) above is assumed to be governed by the following international risk sharing condition:

$$\frac{(1-h)}{\sigma}q_t = (c_t - \mathcal{H}_t) - (y_t^* - \mathcal{H}_t^*) + v_t^q \qquad (6)$$

$\mathcal{H}_t$ and $\mathcal{H}_t^*$ in the above equation represent the relative deviation of the external habit stock with respect to steady state consumption for the domestic small open economy and the foreign sector respectively.

Substituting equation (6) into equation (5) eliminates the real exchange rate term in the market clearing condition. That is:

$$\begin{aligned} y_t \;=\; & \frac{(1-\alpha)^2(1-h) + \alpha(2-\alpha)\eta\sigma}{(1-\alpha)(1-h)}c_t + \frac{\alpha(1-\alpha)(1-h) - \alpha(2-\alpha)\eta\sigma}{(1-\alpha)(1-h)}y_t^* \\ & - \frac{\alpha(2-\alpha)\eta\sigma}{(1-\alpha)(1-h)}\left(\mathcal{H}_t - \mathcal{H}_t^* - v_t^q\right) - \frac{\alpha\eta}{(1-\alpha)}\psi_t \end{aligned}$$

[4] See, e.g., Rotemberg and Woodford (1998), Erceg et al. (2000), Woodford (2003), Walsh (2003) and Edge (2003) for the case of a closed economy; and Batini et al. (2003), Pappa (2004) and Gali and Monacelli (2005) for the open economy case.

Solving for c_t from the above equation gives:

$$c_t = a_1 y_t - a_2 y_t^* + a_3 \left(\mathcal{H}_t - \mathcal{H}_t^* - v_t^q\right) + a_4 \psi_t \tag{7}$$

where $a_1 = \frac{(1-\alpha)(1-h)}{(1-\alpha)^2(1-h)+\alpha(2-\alpha)\eta\sigma}$, $a_2 = \frac{\alpha(1-\alpha)(1-h)-\alpha(2-\alpha)\eta\sigma}{(1-\alpha)^2(1-h)+\alpha(2-\alpha)\eta\sigma}$, $a_3 = \frac{\alpha(2-\alpha)\eta\sigma}{(1-\alpha)^2(1-h)+\alpha(2-\alpha)\eta\sigma}$ and $a_4 = \frac{\alpha\eta(1-h)}{(1-\alpha)^2(1-h)+\alpha(2-\alpha)\eta\sigma}$.

Equation (7) can then be used to substitute for c_t and c_t^2 in the second-order approximation of the consumption part in the utility function (4) to get:

$$U_t = \frac{\bar{C}^{1-\sigma}}{(1-h)^\sigma} a_1 \left\{ y_t + \frac{a_1}{2}\left(1 - \frac{\sigma}{1-h}\right) y_t^2 \right\} + t.i.p + \mathcal{O}\left(\|\xi\|^3\right) \tag{8}$$

The term $t.i.p$ in equation (8) stands for the collection of terms that are independent of monetary policy.

2.1.2 The disutility out of working

The second-order approximation to the disutility out of working term in the within period utility is the following:

$$V_t = \bar{V} + V_{\bar{N}}\left(N_t - \bar{N}\right) + \frac{1}{2} V_{\bar{N}\bar{N}}\left(N_t - \bar{N}\right)^2 + \mathcal{O}\left(\|\xi\|^3\right)$$

$\bar{V}$ and $\bar{N}$ are the equilibrium value of V and N, respectively. As with the case for the consumption part of the utility function, given the particular functional form of the disutility function in (3), the above approximation can also be written as:

$$V_t = \bar{V} + \bar{N}^{1+\varphi} n_t + \frac{1}{2}\bar{N}^{1+\varphi}(1+\varphi) n_t^2 + \mathcal{O}\left(\|\xi\|^3\right) \tag{9}$$

with n denoting the log deviation of hours of labour from its steady state value.

As indicated earlier, total labour hours in each period t (N_t) is the aggregated number of each of the individual i's hours of working $\left(N_t = \int_{i=0}^1 N_t(i)\,\partial i\right)$. The corresponding representative production function utilised in the underlying small open economy model used for the analysis of this paper is assumed to take the following form:

$$Y_t(i) = B_t N_t(i)$$

Given the above production technology, N_t can also be represented as:

$$N_t = \frac{1}{B_t}\int_0^1 Y_t(i)\,\partial i$$

or, in its log linearised form:

$$\begin{aligned} n_t &= \ln\left(\int_0^1 Y_t(i)\,\partial i\right) - b_t \\ &= y_t - b_t \end{aligned} \tag{10}$$

Expression (10) above can be used to substitute for n_t and n_t^2 in the second-order approximation of the disutility out of working in equation (9) to yield:

$$V_t = \bar{N}^{1+\varphi}\left\{ y_t + \frac{(1+\varphi)}{2}\left[y_t^2 + var_i y_t(i)\right] \right\} + t.i.p + \mathcal{O}\left(\|\xi\|^3\right) \tag{11}$$

2.2 The utility-based welfare criterion

The utility-based welfare criterion ($L_t = U_t - V_t$) is obtained by combining the two second-order approximations described in (8) and (11) as discussed above. That is,

$$\begin{aligned} L_t &= \frac{\bar{C}^{1-\sigma}}{(1-h)^{\sigma}} a_1 \left\{ y_t + \frac{a_1}{2} \left(\frac{1-h-\sigma}{1-h} \right) y_t^2 \right\} \\ &\quad - \bar{N}^{1+\varphi} \left\{ y_t + \frac{(1+\varphi)}{2} \left[y_t^2 + var_i y_t (i) \right] \right\} + t.i.p + \mathcal{O}\left(\|\xi\|^3 \right) \end{aligned}$$

When evaluated at the optimum steady state equilibrium, however, the marginal utility of consumption has to be equal to the marginal disutility out of working for each of the representative households. Since this requirement has to hold at the optimum, it is then assumed that $\frac{\bar{C}^{1-\sigma}}{(1-h)^{\sigma}} a_1 = \bar{N}^{1+\varphi} = \Phi$ at steady state. Therefore, the above equation can alternatively be expressed as the following:

$$\begin{aligned} L_t &= \Phi \left\{ \left[\frac{a_1}{2} \left(\frac{1-h-\sigma}{1-h} \right) - \frac{(1+\varphi)}{2} \right] y_t^2 - \frac{(1+\varphi)}{2} var_i y_t (i) \right\} \\ &\quad + t.i.p + \mathcal{O}\left(\|\xi\|^3 \right) \end{aligned} \tag{12}$$

Equation (12) implies that the within period utility-based loss function is not only determined by the output gap, but also by the dispersion of output across firms as well. As argued in Woodford (2003, Chapter 6), this last channel is in fact the one that invokes the relevance of price stability for welfare beyond the mere association between inflation and the aggregate output gap.

Specifically, assume that each of the individual firms faces a constant elasticity demand curve of the form $y_t(i) = y_t - \varepsilon (p_{D,t}(i) - p_t)$. This particular demand curve implies that

$$var_i y_t (i) = \varepsilon^2 var_i p_{D,t} (i) \tag{13}$$

so that equation (12) can also be written as:

$$\begin{aligned} L_t &= -\Phi \left\{ \left[\frac{(1+\varphi)}{2} - \frac{a_1}{2} \left(\frac{1-h-\sigma}{1-h} \right) \right] y_t^2 + \frac{(1+\varphi)\varepsilon^2}{2} var_i p_{D,t} (i) \right\} \\ &\quad + t.i.p + \mathcal{O}\left(\|\xi\|^3 \right) \end{aligned} \tag{14}$$

Expression (14) implies that reducing price dispersion across firms, in addition to stabilising the output gap, is also an appropriate policy objective for a policy maker. As the price set at firm level is affected by the fluctuations in the aggregate price level, the objective to reduce price dispersion can also be achieved through stabilising the aggregate price level. Further, given equation (14), the expression for the level of the representative household's expected stream of utility can be approximated as:

$$\mathbb{W} = \sum_{t=0}^{\infty} \beta^t L_t + t.i.p + \mathcal{O}\left(\|\xi\|^3 \right) \tag{15}$$

The aggregate price level in the underlying model used for the analysis here is formed by a weighted average of both the price of home and imported goods, $p_t = (1-\alpha) p_{D,t} + \alpha p_{F,t}$. Alternatively, p_t can also be written as $p_t \equiv E_i[(1-\alpha) p_{D,t}(i) + \alpha p_{F,t}]$. Therefore, the aggregate price inflation ($p_t - p_{t-1} = \pi_t$) can be expressed as the following:

$$\begin{aligned} \pi_t &= p_t - p_{t-1} \\ &= E_i \left[(1-\alpha) p_{D,t} (i) + \alpha p_{F,t} - p_{t-1} \right] \end{aligned} \tag{16}$$

No individual firm i, however, possesses perfect information over the price setting of the domestic import retailers. To simplify the analysis, it is assumed that firm i expectation about $p_{F,t}$ is simply its past value plus an adjustment made through indexing the price to the last period aggregate inflation; that is, $E_i(p_{F,t}) = p_{F,t-1} + \delta\pi_{t-1}$. Given these assumptions and a Calvo (1983) staggered price mechanism of the domestic producing firms, equation (16) can be expressed as follows:

$$\begin{aligned} \pi_t &= \theta_D E_i \left[(1-\alpha)p_{D,t-1}(i) + \alpha p_{F,t-1} + \alpha\delta\pi_{t-1} - p_{t-1}\right] \\ &\quad + (1-\theta_D) E_i \left[(1-\alpha)p_{D,t}^{new}(i) + \alpha p_{F,t-1} + \alpha\delta\pi_{t-1} - p_{t-1}\right] \\ &= (1-\theta_D)\left[(1-\alpha)p_{D,t}^{new}(i) + \alpha p_{F,t-1} - p_{t-1}\right] + \alpha\delta\pi_{t-1} \end{aligned} \tag{17}$$

Moreover, since p_{t-1} , $p_{F,t-1}$ and π_{t-1} are known at period t, each firm i in the economy will have the same expected value for any of those variables at any time t. Therefore, at any time t, it can be written that $var_i\left(\frac{p_{t-1}}{(1-\alpha)} - \frac{\alpha}{(1-\alpha)}p_{F.t-1} - \frac{\alpha\delta}{(1-\theta_D)(1-\alpha)}\pi_{t-1}\right) = 0$. Letting $\Delta_t = var_i p_{D,t}(i)$, one can then write

$$\Delta_t = var_i\left[p_{D,t}(i) - \left(\frac{p_{t-1}}{(1-\alpha)} - \frac{\alpha}{(1-\alpha)}p_{F.t-1} - \frac{\alpha\delta}{(1-\theta_D)(1-\alpha)}\pi_{t-1}\right)\right]$$

where, given the Calvo (1983) price setting mechanism, can also be written as,

$$\Delta_t = \theta_D\Delta_{t-1} + \frac{\theta_D}{(1-\alpha)}E_i\left[(1-\alpha)p_{D,t}(i) + \alpha p_{F,t-1} + \frac{\alpha\delta}{(1-\theta_D)}\pi_{t-1} - p_{t-1}\right]^2$$

which, given the expression set out in equation (17), boils down to

$$\Delta_t = \theta_D\Delta_{t-1} + \frac{\theta_D}{(1-\theta_D)(1-\alpha)}\pi_t^2 \tag{18}$$

Alternatively, equation (18) can also be written as:

$$\sum_{t=0}^{\infty}\beta^t\Delta_t = \frac{\theta_D}{(1-\theta_D)(1-\alpha)(1-\theta_D\beta)}\sum_{t=0}^{\infty}\beta^t\pi_t^2 + t.i.p + \mathcal{O}\left(\|\xi\|^3\right) \tag{19}$$

Further, equation (19) above can be used to substitute out the discounted sum of $var_i p_{D,t}(i)$ in equation (15), the discounted sum of the utility of the representative household ($\mathbb{W}_t$). Therefore, $\mathbb{W}_t$ can be approximated as:

$$\mathbb{W} = -\sum_{t=0}^{\infty}\beta^t Loss_t + t.i.p + \mathcal{O}\left(\|\xi\|^3\right) \tag{20}$$

The term $Loss_t$ in the equation above represents the within period loss due to variations in the output gap and inflation. That is,

$$Loss_t = \omega y_t^2 + \pi_t^2$$

where the weight for inflation variations $\left(\pi_t^2\right)$ is normalised to be equal to 1; and $\omega = \left[\frac{(1-h)(1+\varphi)-a_1(1-h-\sigma)}{\varepsilon^2(1-h)(1+\varphi)}\frac{(1-\theta_D)(1-\theta_D\beta)(1-\alpha)}{\theta_D}\right]$ is the weight for output gap variations.

3 Measuring Welfare Under Optimal Monetary Policy

Equation (20) can be considered as a representative for the aggregate social welfare function of an economy. A benevolent policy maker (represented by a monetary authority in this particular case), whose objective is to maximise the level of social welfare (minimising the aggregate loss), should then target its policy to maximise equation (20) subject to a set of dynamic constraints representing the dynamics of the economy under consideration.

The general form of the dynamic constraint faced by a monetary authority can be written in the following matrix representation:

$$\boldsymbol{A}_0 \boldsymbol{y}_t = \boldsymbol{A}_1 \; \boldsymbol{y}_{t-1} + \boldsymbol{A}_2 \; E_t \boldsymbol{y}_{t+1} + \boldsymbol{A}_3 \; \boldsymbol{x}_t + \boldsymbol{A}_4 \; \boldsymbol{v}_t; \text{ with } \boldsymbol{v}_t \sim iid \left[\mathbf{0}, \boldsymbol{\Omega}\right] \tag{21}$$

where $\boldsymbol{y}_t$ is a vector of time t endogenous variables in the system; $\boldsymbol{x}_t$ is a scalar or vector of time t control variable(s); $\boldsymbol{v}_t$ is a vector of *iid* innovations to the economy with variance-covariance matrix $\boldsymbol{\Omega}$; and $\boldsymbol{A}_0$, $\boldsymbol{A}_1$, $\boldsymbol{A}_2$, $\boldsymbol{A}_3$ and $\boldsymbol{A}_4$ are conformable matrices containing structural parameters of the economic model under consideration.

The aggregate loss function for an economy can also be presented in a matrix form related to the vectors described in system (21) above. That is,

$$\begin{aligned} \mathbf{Loss}\,(t, \infty) &= -\mathbb{W} \\ &= E_t \sum_{t=0}^{\infty} \beta^t \left[\boldsymbol{y}_t' \boldsymbol{W} \boldsymbol{y}_t\right] \end{aligned} \tag{22}$$

where $\boldsymbol{W}$ is a conformable matrix containing the weights for each of the arguments entering the aggregate loss function. In the context of the functional form given in equation (20), the elements of $\boldsymbol{W}$ are all zero, except for those related to the elements of $\boldsymbol{y}$ that represent inflation (π) and output gap (y) .

3.1 Optimal policy under precommitment

Under an optimal pre-commitment policy regime, a monetary authority pre-commits to a policy plan for all the remaining periods by optimising its policy once only, at some initial period $(t = 0)$. In a rational expectation environment, the time $t+1$ variables can be stated as their expected values plus an expectation error. Therefore,

$$\boldsymbol{y}_{t+1} = E_t \boldsymbol{y}_{t+1} + \boldsymbol{u}_{t+1} \tag{23}$$

Further, (23) can be used to eliminate the expectation operator in (21).

In order to solve for the optimal policy under pre-commitment, a monetary authority minimises the objective function in equation (22) subject to a set of the dynamic constraints (21) of the economy. One way to solve this problem is by forming a Lagrangian for the problem at hand.[5]

$$\mathcal{L} = E_t \sum_{t=0}^{\infty} \beta^t [\boldsymbol{y}_t' \boldsymbol{W} \boldsymbol{y}_t + 2\boldsymbol{\lambda}_t' \left(\boldsymbol{A}_0 \boldsymbol{y}_t - \boldsymbol{A}_1 \; \boldsymbol{y}_{t-1} - \boldsymbol{A}_2 \; E_t \boldsymbol{y}_{t+1} - \boldsymbol{A}_3 \; \boldsymbol{x}_t - \boldsymbol{A}_4 \; \boldsymbol{v}_t\right)]$$

$\boldsymbol{\lambda}_t$ in the above equation is a vector of Lagrange multiplier for period t. Differentiating the above Langragian problem with respect to $\boldsymbol{x}_t$, $\boldsymbol{y}_t$ and $\boldsymbol{\lambda}_t$ yields the first order necessary

[5] Alternatively, the problem can also be solved using the conventional dynamic programming method as shown in Backus and Driffill (1986); as applied in e.g. Jensen (2002).

conditions for the optimal solution:

$$\frac{\partial \mathcal{L}}{\partial \boldsymbol{y}_t} = \boldsymbol{W}\boldsymbol{y}_t + \boldsymbol{A}_0' \boldsymbol{\lambda}_t - \beta^{-1}\boldsymbol{A}_2'\boldsymbol{\lambda}_{t-1} - \beta \boldsymbol{A}_1'\boldsymbol{\lambda}_{t+1} = \boldsymbol{0} \tag{24}$$

$$\frac{\partial \mathcal{L}}{\partial \boldsymbol{x}_t} = -\boldsymbol{A}_3'\boldsymbol{\lambda}_t = \boldsymbol{0} \tag{25}$$

$$\frac{\partial \mathcal{L}}{\partial \boldsymbol{\lambda}_t} = \boldsymbol{A}_0\boldsymbol{y}_t - \boldsymbol{A}_1\boldsymbol{y}_{t-1} - \boldsymbol{A}_2 E_t\boldsymbol{y}_{t+1} - \boldsymbol{A}_3\boldsymbol{x}_t - \boldsymbol{A}_4\boldsymbol{v}_t = \boldsymbol{0} \tag{26}$$

As is well-known, following the argument put forward by Kydland and Prescott (1977), a problem with solving for optimal policy under pre-commitment in the presence of forward-looking constraints is that the solution is generally not time consistent. This problem arises due to the fact that an optimal commitment policy designed at the initial period is no longer optimum in the eyes of a policy maker, once the private sector expectation is formed under that given policy. To circumvent this problem, however, one can impose an additional set of constraints on the acceptable values of the initial conditions on $\boldsymbol{y}_{-1}$ and $\boldsymbol{\lambda}_{-1}$ that are self-consistent. That is, the chosen policy subject to these constraints would also satisfy constraints of exactly the same form in the future periods.[6]

Dennis (2007) shows that constraining $\boldsymbol{y}_{-1} = \bar{\boldsymbol{y}}$ (the steady state equilibrium value of $\boldsymbol{y}$) and $\boldsymbol{\lambda}_{-1} = \boldsymbol{0}$ give sufficient restrictions to guarantee that the above argument holds. Given $\boldsymbol{y}_{-1} = \bar{\boldsymbol{y}}$ and $\boldsymbol{\lambda}_{-1} = \boldsymbol{0}$, the set of first order necessary conditions in equation (24), (25) and (26) holds for every time $t \geq 0$. Therefore, they can be represented as the following second-order system of difference equations:

$$\begin{bmatrix} \boldsymbol{0} & \boldsymbol{A}_0 & -\boldsymbol{A}_3 \\ \boldsymbol{A}_0' & \boldsymbol{W} & \boldsymbol{0} \\ -\boldsymbol{A}_3' & \boldsymbol{0} & \boldsymbol{0} \end{bmatrix} \begin{bmatrix} \boldsymbol{\lambda}_t \\ \boldsymbol{y}_t \\ \boldsymbol{x}_t \end{bmatrix} = \begin{bmatrix} \boldsymbol{0} & \boldsymbol{A}_1 & \boldsymbol{0} \\ \beta^{-1}\boldsymbol{A}_2' & \boldsymbol{0} & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{0} \end{bmatrix} \begin{bmatrix} \boldsymbol{\lambda}_{t-1} \\ \boldsymbol{y}_{t-1} \\ \boldsymbol{x}_{t-1} \end{bmatrix} + \begin{bmatrix} \boldsymbol{0} & \boldsymbol{A}_2 & \boldsymbol{0} \\ \beta\boldsymbol{A}_1' & \boldsymbol{0} & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{0} \end{bmatrix} E_t \begin{bmatrix} \boldsymbol{\lambda}_{t+1} \\ \boldsymbol{y}_{t+1} \\ \boldsymbol{x}_{t+1} \end{bmatrix} + \begin{bmatrix} \boldsymbol{A}_4 \\ \boldsymbol{0} \\ \boldsymbol{0} \end{bmatrix} \boldsymbol{v}_t \tag{27}$$

The second-order difference system in (27) can be solved using the method of undetermined-coefficient.[7] The solution obtained is a first-order system of the form:

$$\begin{bmatrix} \boldsymbol{\lambda}_t \\ \boldsymbol{y}_t \\ \boldsymbol{x}_t \end{bmatrix} = \begin{bmatrix} \boldsymbol{H}_{11} & \boldsymbol{H}_{12} & \boldsymbol{0} \\ \boldsymbol{H}_{21} & \boldsymbol{H}_{22} & \boldsymbol{0} \\ \boldsymbol{H}_{31} & \boldsymbol{H}_{32} & \boldsymbol{0} \end{bmatrix} \begin{bmatrix} \boldsymbol{\lambda}_{t-1} \\ \boldsymbol{y}_{t-1} \\ \boldsymbol{x}_{t-1} \end{bmatrix} + \begin{bmatrix} \boldsymbol{G}_1 \\ \boldsymbol{G}_2 \\ \boldsymbol{G}_3 \end{bmatrix} \boldsymbol{v}_t \tag{28}$$

or, in more compact notation:

$$\boldsymbol{s}_t = \boldsymbol{H}\boldsymbol{s}_{t-1} + \boldsymbol{G}\boldsymbol{v}_t \tag{29}$$

The optimal commitment rule is embedded in (28), particularly represented by the third row of the vector on the left hand side and its corresponding terms in the right hand side of the equation. Aside from responding to the development in the state variables, the vector of policy variables also responds to the Lagrange multipliers of the system. These Lagrange multipliers enter the optimal policy feedback rule in order to ensure the validations of past formation of the private sector expectations by the current policy maker.

To measure the welfare implication from this optimal pre-commitment policy, one can proceed by calculating the resulting loss given the optimal policy. To do so, the loss

[6] See, for example, discussion in Benigno and Woodford (2006a,b).

[7] Ways to implement the method can be found in Binder and Pesaran (1995), McCallum (1998), Uhlig (1999) or Christiano (2002).

function in (22) can be rewritten as

$$
\begin{aligned}
\textbf{Loss}\,(t,\infty) &= E_t \sum_{t=0}^{\infty} \beta^t \left[\boldsymbol{s}_t' \boldsymbol{K}\, \boldsymbol{s}_t \right] \qquad (30) \\
&= \boldsymbol{s}_t' \left(\sum_{t=0}^{\infty} \beta^t \boldsymbol{H}'^t \boldsymbol{K} \boldsymbol{H}^t \right) \boldsymbol{s}_t + \frac{\beta}{1-\beta} \left[\sum_{t=0}^{\infty} \beta^t tr \left(\boldsymbol{G}' \boldsymbol{H}'^t \boldsymbol{K} \boldsymbol{H}^t \boldsymbol{G} \boldsymbol{\Omega} \right) \right]
\end{aligned}
$$

where $\boldsymbol{K}$ is defined as

$$
\boldsymbol{K} = \begin{bmatrix} \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \boldsymbol{W} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} \end{bmatrix}
$$

to match the elements in $\boldsymbol{s}$. Assuming that $0 < \beta < 1$ and the stability properties in (29) hold, Dennis (2007) shows that the expression in (30) can be simplified to

$$
\textbf{Loss}\,(t,\infty) = \boldsymbol{s}_t'\, \boldsymbol{P} \boldsymbol{s}_t + \frac{\beta}{1-\beta} tr \left(\boldsymbol{G}' \boldsymbol{P} \boldsymbol{G} \boldsymbol{\Omega} \right) \qquad (31)
$$

where $\boldsymbol{P} = \boldsymbol{K} + \beta \boldsymbol{H}' \boldsymbol{P} \boldsymbol{H}$.[8] Given the associated $\boldsymbol{s}$, $\boldsymbol{\Omega}$, β and the relevant coefficient matrices, the value of the loss function can be evaluated.

3.2 Optimal policy under discretion

Under an optimal discretionary policy, a monetary authority re-optimises its policy on a period by period basis. Any set of policy feedback parameters chosen in one period does not impose any restriction on the set of possible feedback parameters for the subsequent policy maker. However, a feedback rule chosen in one period does affect the dynamics of the economy through time. Therefore, the dynamics of the economy in this case follow a Stackelberg-Nash equilibrium, where the policy maker optimising today can be considered as a Stackelberg leader, while the other economic agents and the subsequent policy makers are the Stackelberg followers.

Due to its inability to control the future dynamics of the economy, a monetary authority optimising at time t assumes that (in equilibrium) all the endogenous variables and the policy instruments in the system are governed by their relevant state-endogenous variables. That is,

$$
\begin{aligned}
\boldsymbol{y}_t &= \boldsymbol{H}_1 \boldsymbol{y}_{t-1} + \boldsymbol{H}_2\, \boldsymbol{v}_t \qquad (32) \\
\boldsymbol{x}_t &= \boldsymbol{F}_1 \boldsymbol{y}_{t-1} + \boldsymbol{F}_2\, \boldsymbol{v}_t \qquad (33)
\end{aligned}
$$

where $\boldsymbol{H}_1$, $\boldsymbol{H}_2$, $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$ are the time-invariant matrices of parameters that govern the dynamics of the economy, once the optimal discretionary policy problem is solved. Note also that at the optimum, equation (33) represents the optimal feedback rule for the vector of policy variables that a policy maker will choose if they are to minimise the relevant loss function under consideration.

Substituting equation (32) into equation (21) gives

$$
\boldsymbol{D} \boldsymbol{y}_t = \boldsymbol{A}_1\, \boldsymbol{y}_{t-1} + \boldsymbol{A}_3\, \boldsymbol{x}_t + \boldsymbol{A}_4\, \boldsymbol{v}_t \qquad (34)
$$

where $\boldsymbol{D} = \boldsymbol{A}_0 - \boldsymbol{A}_2\, \boldsymbol{H}_1$. This form of dynamic constraint system sets the information

[8] This result is obtained by exploiting the properties of a convergent infinite series; where for $0 < \beta < 1$ and a matrix $\boldsymbol{\theta}$ with spectral radius less than 1, an infinite series $\boldsymbol{X} = \sum_{j=0}^{\infty} \beta^j \boldsymbol{\theta}'^j \boldsymbol{W} \boldsymbol{\theta}^j$ is convergent. Therefore, $\beta \boldsymbol{\theta}'\ \boldsymbol{X} \boldsymbol{\theta} = \sum_{j=1}^{\infty} \beta^j \boldsymbol{\theta}'^j \boldsymbol{W} \boldsymbol{\theta}^j\ = \boldsymbol{X} - \boldsymbol{W}$. Consequently, $\boldsymbol{X}$ can be solved by finding a fixed point solution to $\boldsymbol{X} = \boldsymbol{W} + \beta \boldsymbol{\theta}'^j \boldsymbol{X} \boldsymbol{\theta}^j$.

of how future policy makers respond to movements in $\boldsymbol{y}_t$. This information is taken into account by today's policy maker in setting its policy. It is in this sense that the current policy maker leads the future policy maker decisions.

Given equation (32), the loss function in (22) can also be written as

$$\begin{aligned} \mathbf{Loss}\,(t,\infty) &= \boldsymbol{y}_t'\left(\sum_{t=0}^{\infty}\beta^t \boldsymbol{H}_1'^t \boldsymbol{W}\boldsymbol{H}_1^t\right)\boldsymbol{y}_t \\ &\quad + \frac{\beta}{1-\beta}\left[\sum_{t=0}^{\infty}\beta^t tr\left(\boldsymbol{H}_2'\boldsymbol{H}_1'^t\boldsymbol{W}\boldsymbol{H}_1^t\boldsymbol{H}_2\boldsymbol{\Omega}\right)\right] \end{aligned} \quad (35)$$

Therefore, provided that the spectral radius of $\boldsymbol{H}_1$ is less than one, equation (35) points to:

$$\mathbf{Loss}\,(t,\infty) = \boldsymbol{y}_t'\,\boldsymbol{S}\boldsymbol{y}_t + \frac{\beta}{1-\beta}tr\left(\boldsymbol{H}_2'\boldsymbol{S}\boldsymbol{H}_2\boldsymbol{\Omega}\right) \quad (36)$$

with $\boldsymbol{S} = \boldsymbol{W} + \beta\boldsymbol{H}_1'\boldsymbol{S}\boldsymbol{H}_1$.

To discover the optimal discretionary policy rule, one can simply proceed by minimising the social loss function in (36) subject to the system of dynamic constraints in (34). Given the problem at hand, one can substitute equation (34) into (36) and solve for an unconstrained optimisation problem instead. That is,

$$\begin{aligned} \mathbf{Loss}\,(t,\infty) &= \left(\boldsymbol{A}_1\boldsymbol{y}_{t-1} + \boldsymbol{A}_3\,\boldsymbol{x}_t + \boldsymbol{A}_4\,\boldsymbol{v}_t\right)'\boldsymbol{D}'^{-1}\boldsymbol{S}\boldsymbol{D}^{-1}\left(\boldsymbol{A}_1\boldsymbol{y}_{t-1} + \boldsymbol{A}_3\,\boldsymbol{x}_t + \boldsymbol{A}_4\,\boldsymbol{v}_t\right) \\ &\quad + \frac{\beta}{1-\beta}tr\left(\boldsymbol{H}_2'\boldsymbol{S}\boldsymbol{H}_2\boldsymbol{\Omega}\right) \end{aligned}$$

Differentiating the above with respect to $\boldsymbol{x}_t$ and setting the first order necessary condition gives

$$\boldsymbol{A}_3'\boldsymbol{D}'^{-1}\boldsymbol{S}\boldsymbol{D}^{-1}\left(\boldsymbol{A}_1\boldsymbol{y}_{t-1} + \boldsymbol{A}_3\,\boldsymbol{x}_t + \boldsymbol{A}_4\,\boldsymbol{v}_t\right) = \mathbf{0}$$

Therefore,

$$\begin{aligned} \boldsymbol{x}_t &= \left(\boldsymbol{A}_3'\boldsymbol{D}'^{-1}\boldsymbol{S}\boldsymbol{D}^{-1}\boldsymbol{A}_3\right)^{-1}\boldsymbol{A}_3'\boldsymbol{D}'^{-1}\boldsymbol{S}\boldsymbol{D}^{-1}\left(\boldsymbol{A}_1\boldsymbol{y}_{t-1} + \boldsymbol{A}_4\,\boldsymbol{v}_t\right) \\ &= \boldsymbol{F}_1\boldsymbol{y}_{t-1} + \boldsymbol{F}_2\,\boldsymbol{v}_t \end{aligned} \quad (37)$$

The last line in the above expression comes from the expression set out in equation (33) earlier. Substituting the last line above – equation (37) – into equation (34), one gets

$$\begin{aligned} \boldsymbol{y}_t &= \boldsymbol{D}^{-1}\left[\left(\boldsymbol{A}_1 + \boldsymbol{A}_3\,\boldsymbol{F}_1\right)\boldsymbol{y}_{t-1} + \left(\boldsymbol{A_4} + \boldsymbol{A_3}\,\boldsymbol{F_2}\right)\boldsymbol{v}_t\right] \\ &= \boldsymbol{H}_1\boldsymbol{y}_{t-1} + \boldsymbol{H}_2\,\boldsymbol{v}_t \end{aligned} \quad (38)$$

Notice that both $\boldsymbol{S}$ and $\boldsymbol{D}$ are implicit functions of $\boldsymbol{H}_1$, $\boldsymbol{H}_1$, $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$. Consequently, one needs to find a fixed point solution for equation (37) and (38) in order to get the desired matrices of the optimal parameters under a discretionary regime.

The above discussion demonstrates that the approach used to solve for an optimum discretionary policy problem is done through formulating it as a recursive optimisation problem and iterating backward through time to solve for the Markov-perfect Nash-equilibrium. The resulting equilibrium is then time-consistent, as pointed out by, among others, Dennis (2004b).[9]

[9] For a proof, see, for example, Dockner et al. (2000, Theorem 4.3).

4 Monetary Policy in the ASEAN-5: Commitment vs. Discretion

This section applies the approaches above to measure welfare implications of pursuing optimal monetary policy for the cases of ASEAN-5 countries. The set of dynamic constraints used in the optimisation problem are the log-linearised version of an extended Gali and Monacelli (2005) small open economy model with ten equations governing the dynamics of the economy as presented in the Appendix to this paper. The model is a simple version of a dynamic New Keynesian small open economy model, which features imperfect competition and nominal price rigidities, an incomplete pass-through effect in the import sector with a staggered price setting in the domestic imported goods market, and external habit formation in the consumer's utility.

To obtain results for both an optimal monetary policy feedback rule under pre-commitment and under discretion, the objective function stated in equation (22) is optimised subject to the dynamic constraints using the algorithm proposed by Dennis (2007). This algorithm has an advantage in allowing one to cast the optimisation constraints in terms of their structural form, as set out in expression (21), rather than having to convert them into a state-space representation, as commonly required in the existing alternative algorithms (e.g. the algorithm set out in Backus and Driffill, 1986; Soderlind, 1999). Therefore, it offers convenience in setting up the optimisation problem.

4.1 Setting up the problem

The relevant dynamic constraints (as shown by the set of equations in the Appendix) for each of the ASEAN-5 economies are fitted into the system expressed in (21). The equation for the interest reaction function, however, is discarded when setting up $\boldsymbol{y}_t$. This is done in order to free the monetary policy feedback rule to be determined by the optimisation process without posing any particular constraint on its form. To conduct the optimisation, the coefficient matrices $\boldsymbol{A}_0$, $\boldsymbol{A}_1$, $\boldsymbol{A}_2$, $\boldsymbol{A}_3$ and $\boldsymbol{A}_4$ for each of the economies in the group of ASEAN-5 countries are filled with the relevant parameters obtained from the empirical estimation of the small open economy model done in Ramayandi (2008). Table 1 summarises the "deep" structural parameters used to conduct the optimisation.

As discussed in section 2.2, the weight coefficient for inflation variation in the aggregate loss function (22) is normalised to 1. The weight for output gap (ω) for each country can be calculated using the parameters supplied in Table 1. However, as shown in the last part of section 2.2, ω is also determined by the elasticity of substitution between differentiated goods of the same origin (ε). For the purpose of computation, this last parameter is set according to the value used for calibrating a similar model in Gali and Monacelli (2005). That is, ε is set to be equal to 6 for all of the countries, which implies a common average steady state mark-up value (μ) of 1.2 for all economies.[10] Given these parameters, the weight for output gap variations in the aggregate loss function (ω) for each country under consideration is reported in Table 2.

An interesting observation emerges from Table 2. Under the approach employed to derive the approximate utility-based welfare criterion in section 2, the weight for output gap variation in the aggregate loss function is very small relative to the weight for the variation in inflation.[11] In the terminology of Svensson (1999, 2000), this form of aggregate social loss function approximates the one he termed as a strict inflation targeting regime.

[10] Note that at a steady state equilibrium, $\mu = \frac{\varepsilon}{\varepsilon - 1}$ in this class of model.

[11] Based on the derivation of this parameter in section 2.2, the lower the steady state mark-up value in the economy (that is, the more competitive the market for a good from the same origin in the economy), the lower the relative weight for output gap variation in the aggregate loss function would be.

Table 1: Structural parameters of the small open economy model

Parameter	Indonesia	Malaysia	Philippines	Singapore	Thailand
α	0.30	0.65	0.49	0.80	0.48
β	0.963	0.988	0.972	0.992	0.984
δ	0.92	0.49	0.49	0.61	0.65
σ	0.86	0.32	0.09	0.17	0.74
θ_D	0.92	0.82	0.76	0.83	0.94
θ_F	0.91	0.89	0.77	0.89	0.98
φ	1.99	1.99	1.00	4.79	1.49
η	0.003	0.39	0.08	0.29	0.43
h	0.77	0.55	0.97	0.25	0.81
ρ_ψ	0.99	0.99	0.88	0.99	0.85
ρ_b	0.61	0.81	0.89	0.91	0.60
ρ_i	0.52	0.69	0.55	0.85	0.70
κ_1	1.78	1.66	0.72	1.27	2.65
κ_2	1.04	0.19	1.60	0.94	0.00
σ_b	0.46	0.16	0.01	0.01	0.37
σ_c	0.03	0.05	0.02	0.12	0.05
σ_i	0.035	0.07	0.02	0.006	0.016
σ_ψ	0.08	0.06	0.10	0.03	0.07
σ_q	0.09	0.10	0.05	0.14	0.11

Table 2: Relative weights for the output gap variations

Country	ω
Indonesia	0.0005
Malaysia	0.0003
Philippines	0.0022
Singapore	0.0002
Thailand	0.0001

Given values for the parameters described in Tables 1 and 2, all the coefficient matrices needed to solve the optimisation problem described earlier ($\boldsymbol{W}$, $\boldsymbol{A}_0$, $\boldsymbol{A}_1$, $\boldsymbol{A}_2$, $\boldsymbol{A}_3$ and $\boldsymbol{A}_4$) can be characterised for each of the countries. The results of each of the exercises are reported and discussed in what follows.

4.2 Results: Commitment vs. discretion

Table 3 summarises the results of the simulation exercise conducted for the cases of optimal monetary policy (i.e. under pre-commitment and under discretion). The table provides three main results that are of interest for both cases. The first two rows spell out the metric for the welfare implication (the value of the loss function) under the two policy regimes for each of the countries. The third row gives the measure of welfare gain from moving from a discretionary policy regime to adopting a pre-commitment regime. This gain in welfare is measured as the size of relative change in the value of the metric of welfare as one moves from adopting an optimum discretionary policy to an optimum pre-commitment policy (welfare gain $= 1 - \frac{L_C}{L_D}$, where L_C is the value of the loss function under pre-commitment and L_D is the value of the loss function under discretion). The last part of the table shows the comparison of the unconditional variances of four key variables – inflation (π), output gap (y), real exchange rate (q) and interest rate (i) – between the two policy regimes.[12]

[12] To obtain the unconditional variances, I use the doubling algorithm of Hansen and Sargent (1998) to solve for the fixed point solution to the unconditional variance-covariance matrix of all the variables

Table 3: Comparison of optimum monetary policy rules

	Indonesia	Malaysia	The Philippines	Singapore	Thailand
100 x Loss (PC)	0.0045	0.0012	0.0002	0.0001	0.0004
100 x Loss (D)	0.0060	0.0013	0.0003	0.0001	0.0006
Welfare gain	0.2535	0.1193	0.3242	0.0529	0.3886
Unconditional variances (under pre-commitment):					
π (x 10^5)	0.3466	0.0171	0.0059	0.0001	0.0626
y	0.0971	0.0420	0.0013	0.0067	0.0314
q	0.5935	0.0373	0.0050	0.0014	0.1557
i	0.1166	0.0055	0.0054	0.0013	0.2014
Unconditional variances (under discretion):					
π (x 10^5)	2.3132	0.2174	0.1454	0.0058	0.3276
y	0.0918	0.0420	0.0013	0.0067	0.0288
q	0.6052	0.0377	0.0048	0.0014	0.1615
i	0.1638	0.0058	0.0057	0.0013	0.2000

Note:
PC = pre-commitment
D = discretion

The results presented in Table 3 are largely consistent with conventional wisdom from the literature, which argues that an optimal pre-commitment policy is superior in terms of welfare implication. Although with varying degrees, the superiority of the optimal pre-commitment policy holds for all the five countries in the sample. The reason for this, once the time-inconsistency problem has been dealt with appropriately, comes from the fact that a policy maker is taking into account the effect of its policy on private sector expectations when designing its policy. Therefore, resulting policies tend to drive more socially optimal outcomes.

The monetary authority's inability to pre-commit will penalise the economic welfare of the economy. The literature records that a welfare gain from switching to an optimal pre-commitment regime averages at around 20 per cent under simulations using different available macroeconomic dynamic models. For example, the simulation by Jensen (2002) produces welfare gain of around 22 per cent; Dennis (2004b) simulates the welfare implication from switching regimes using the model given by Clarida et al. (1999) and produces a welfare gain of around 26 per cent; Dennis and Soderstrom (2006) report a gain of similar magnitude (around 21 to above 30 per cent) when conducting the simulation using a larger model of Orphanides and Wieland (2000), but relatively smaller magnitude of around 14 to 20 per cent of gains when simulating using the model from Fuhrer and Moore (1995).

For the case of the five ASEAN economies in this paper, the gains from moving from an optimal discretionary regime to a regime based on commitment are also found to be positive in all cases. The welfare gain varies from a little over 5 per cent in the case of Singapore to almost 39 per cent in the case of Thailand. This observation is largely in line with the general observation obtained from using models with similar dynamic characteristics and the timing of expectation formation in the literature as discussed above.[13]

According to the simulation results of the five ASEAN economies under consideration, Thailand and the Philippines are among the top gainers, followed by Indonesia, Malaysia and Singapore (where the gain from switching the regime is the smallest among the

involved in the system.

[13] Dennis and Soderstrom (2006) show that the timing of expectation formation matters for determining the welfare gain from switching policy regime from discretion to commitment. In the case where expectations are formed using lagged information, the gain from switching regimes tend to drop significantly.

sample). It therefore suggests that a radical change towards adopting an optimal pre-commitment regime in conducting monetary policy will substantially benefit countries like Thailand, the Philippines, Indonesia and Malaysia. In the case of Singapore, although there will still be benefit, its magnitude is not going to be as large.

An optimal policy under pre-commitment is also generally recognised for leading to lower volatility in inflation and interest rates, but more volatility in the measure of the output gap. In general, this feature is also confirmed by the simulation results for the five ASEAN economies. Additionally, the simulation for these cases also points to a generally lower volatility in the real exchange rate as well. Although the simulation confirms the higher output gap volatility under a pre-commitment regime, the difference is relatively marginal in each of the ASEAN-5 cases. This observation suggests that even though the objective function used to conduct the analysis is close to Svensson's (1999) strict inflation targeting regime, the optimal pre-commitment policy will still produce superior outcomes for stabilising the economy in general.

5 Welfare Under the Current State of Policy Feedback Rule

The previous section discussed the welfare implications of monetary policy under two different optimal monetary policy environments, pre-commitment and discretion. Under these policy environments, the optimal policy takes the form of a feedback rule on the vector of state variables in the system. That is, all the state variables are used as relevant information for determining the movements in the policy variable (the interest rate in this particular case). As mentioned earlier, in the case where a monetary authority is able to pre-commit to a single policy plan for the remaining periods, the policy feedback rule utilises more information by also including the vector of Lagrange multipliers obtained from the optimisation. This latter feature represents the cost that the policy maker has to pay for honouring the commitments made in the past. However, this cost is, to an extent, also playing a role in driving the pre-commitment regime to deliver a relatively more efficient social welfare outcome.

Although the policy feedback rules under the optimal pre-commitment include the vector of Lagrange multipliers in their set of monetary policy information, this vector can always be eliminated by substituting them out using the relevant relationships between this vector and the vector of state variables obtained from the first order necessary conditions of the optimisation problem.[14] By doing so, both the policy feedback rules under pre-commitment and under discretion will have the same set of information, but different parameters.

The above discussion highlights the point that an optimal feedback rule adopted by a monetary authority in conducting its policy is not simple. But even if that is the case, representing a policy feedback rule in a simpler representation, as widely discussed in the literature, still offers benefits. Among others, a simple policy feedback rule can generally provide a compact representation of the actual policy decision taken by the monetary authority, as long as it is able to approximate the setting of a policy instrument without too much deviation. A simple approximation of policy feedback rules that falls into this category is also preferable since it is generally easier to understand for the private agents, especially when guiding them in forming their expectations. However, simple feedback rules are, by construction, inefficient relative to the fully optimum ones.

Particularly in the case of the five ASEAN economies considered in this paper, where the actual conduct of monetary policy is not being disclosed openly, such an approximation

[14] This substitution can be done since a linear relationship between the Lagrange multipliers and the state vector exists in the class of problem discussed in this paper. See Backus and Driffill (1986) for the discussions.

is helpful in understanding the conduct of monetary policy. For the sample countries under consideration, an approximation to the policy feedback rule in the form of a simple monetary policy reaction function performs relatively well. These simple rules mainly follow the Taylor (1993) type of policy reaction function of the form:

$$i_t = (1 - \rho_i)(\kappa_1 E_t \pi_{t+n} + \kappa_2 y_t) + \rho_i i_{t-1} + \upsilon_t^i \tag{39}$$

where i_t, $E_t \pi_{t+n}$,[15] y_t and υ_t^i are the interest rate, expected inflation, output gap and the unexpected component of monetary policy innovation, respectively, and κ_1, κ_2 and ρ_i are the relevant parameters with the assigned values for each country as stated in Table 1.

Although the formulation in equation (39) is often considered to be more appropriately interpreted as an equilibrium relationship among endogenous variables (Svensson, 2003), the characterised simple rule above is taken as the representation of a simple monetary policy feedback rule for each of the ASEAN-5 countries analysed in this paper. Using these to govern the movement in interest rates, the value of the social loss function (as a metric of the welfare implication of monetary policy) for each of the countries can be calculated. The resulting values can then be compared to the values obtained under the optimal policy environments to get a rough picture of how efficient the conduct of monetary policy has been.

5.1 Measuring welfare under the current feedback rule

Welfare implications under the current feedback policy rule, as represented by the simple Taylor-type rule in equation (39), can be measured by taking the rule into account when defining the dynamic constraints of the economy. Unlike the treatment under the fully optimal policy environment, where the monetary policy feedback rule is to be determined by the optimisation process, the policy rule under this environment is restricted to take the form stated in equation (39). Therefore, one can re-arrange the system of dynamic constraints facing the economy in (21) into the following form:

$$\begin{bmatrix} \boldsymbol{A}_0 & -\boldsymbol{A}_3 \\ -\varkappa_2 & 1 \end{bmatrix} \begin{bmatrix} \boldsymbol{y}_t \\ i_t \end{bmatrix} = \begin{bmatrix} \boldsymbol{A}_1 & \boldsymbol{0} \\ \boldsymbol{0} & \rho_i \end{bmatrix} \begin{bmatrix} \boldsymbol{y}_{t-1} \\ i_{t-1} \end{bmatrix} + \begin{bmatrix} \boldsymbol{A}_2 & \boldsymbol{0} \\ \varkappa_1 & 0 \end{bmatrix} \begin{bmatrix} \boldsymbol{y}_{t+1} \\ i_{t+1} \end{bmatrix} + \begin{bmatrix} \boldsymbol{A}_4 & \boldsymbol{0} \\ \varkappa_3 & 0 \end{bmatrix} \begin{bmatrix} \boldsymbol{v}_t \\ 0 \end{bmatrix}$$

or, in more compact notation:

$$\boldsymbol{B}_0 \boldsymbol{z}_t = \boldsymbol{B}_1 \, \boldsymbol{z}_{t-1} + \boldsymbol{B}_2 \, \boldsymbol{z}_{t+1} + \boldsymbol{B}_3 \, \boldsymbol{v}_t \tag{40}$$

$\varkappa_{1,2}$ are vectors containing the relevant parameters that characterise the relationship between the interest rate (the policy variable) and the endogenous variables in $\boldsymbol{y}_{t+1,t}$ in the simple feedback rule, respectively. $\varkappa_3$ is a vector containing 1 for the element corresponding to the unexpected component of monetary policy innovation (υ_t^i) in $\boldsymbol{v}_t$ and zero otherwise.[16]

Expression (40) above simply stacks the simple policy reaction function into the system of dynamic constraints as summarised in equation (21) and re-arranges its form. Consequently, equation (40) gives a complete summary of the dynamics of the economy as presented in Appendix **??**. Given this, one can rewrite the expression in (22) in terms of

[15] $n = 1$ applies to all the ASEAN-5 countries under consideration except for Singapore, where $n = 0$.

[16] Note, however, the system representation in (40) applies generally to all the ASEAN-5 economies except for Singapore. In the latter case, the policy instrument is only reacting to the contemporaneous development in both inflation and the output gap. Therefore, the vector $\varkappa_2$ contains non-zero parameters for the elements that correspond to π_t and y_t in $\boldsymbol{y}_t$ and zero otherwise. On the other hand, the vector $\varkappa_1$ is a zero vector in this case.

$\boldsymbol{z}_t$ rather than $\boldsymbol{y}_t$, and solve for the value of the social loss function based on the approach explained for solving the values under optimal policy environments discussed earlier.[17]

5.2 Results

Table 4 summarises the values of the social loss function under the current policy feedback rule employed for each of the ASEAN-5 countries. The table also spells out the parameter values characterising the policy reaction function in each country and the corresponding unconditional variances for inflation, output gap, real exchange rate and interest rate.

Table 4: Welfare implications of the current policy

	Indonesia	Malaysia	The Philippines	Singapore	Thailand
100 x Loss	0.5856	0.2328	0.0864	1.9795	0.0142
Policy parameters:					
κ_1	1.7800	1.6600	0.7196	1.2700	2.6500
κ_2	1.0400	0.1900	1.5960	0.9382	0.0000
ρ_i	0.5200	0.6900	0.5456	0.8525	0.7000
Unconditional variances:					
π	0.0072	0.0029	0.0010	0.0310	0.0001
y	0.0033	0.0289	0.0003	0.0091	0.1098
q	0.1320	0.0200	0.0146	0.0021	0.2267
i	0.0115	0.0033	0.0011	0.0301	0.0007

An obvious observation immediately stands out from comparing the set of values for the loss functions in Table 4 with the ones obtained under the optimal policy regimes reported in Table 3. Values obtained under the current simple policy feedback rule are much higher than those obtained under the fully optimal rules. Observation of the difference in the magnitude of the corresponding unconditional variance of inflation offers an explanation for this outcome. As the metric of the loss functions differ enormously, the differences in unconditional variance of inflation are also massive. Under the loss function that approximates Svensson's strict inflation regime, the optimal rules work their way to minimise the unconditional variance of inflation. Therefore, it minimises the social welfare function. This mechanism does not seem to be as pronounced in the case of the current simple policy feedback rule. Consequently, the latter case is characterised by higher values of the loss function as an implication.

A large difference between the metric of welfare obtained under the current policy rule and the one obtained under a utility-based social loss function, however, is not surprising. A similar observation also appears in Batini et al. (2003), where simple policy feedback rules that optimise an ad-hoc loss function return higher values when applied to a loss function derived from a utility function. This observation indicates that the simple policy feedback rules reported in Table 4 are not designed to optimise the specified social loss function used to calculate the metric for welfare implications in this paper. In other words, the likely representation of the simple policy feedback rule for each of the ASEAN-5 countries analysed in this paper suggests that the monetary authority in these countries are not

[17] In this case, the matrix representation of the social loss function can be written as:

$$\mathbf{Loss}\,(t,\infty) = E_t \sum_{t=0}^{\infty} \beta^t \left[\boldsymbol{z}_t' \boldsymbol{Q} \boldsymbol{z}_t\right]$$

with $\boldsymbol{Q} = \begin{bmatrix} \boldsymbol{W} & \mathbf{0} \\ \mathbf{0} & 0 \end{bmatrix}$.

optimising the social loss function as derived earlier in the paper. Even if they were optimising at all, the form of the objective function must have been different.

The last point described in the previous paragraph is supported by differences in the variance of the four key variables reported in Table 3 and 4. Simulations for the cases of Indonesia, Malaysia and the Philippines suggest a lower variance for output gap under the simple feedback rule. This difference hints at the possibility that monetary authorities in these three countries may give more attention to stabilising the output gap in their actual policy setting than what is suggested by their corresponding utility-based welfare criterion. A similar argument also applies for the lower real exchange rate variability under the simple policy feedback rule reported in the cases of Indonesia and Malaysia. Although these two countries may not be explicitly targeting their real exchange rate, a low variance of this variable produced under the simple policy rule does hint at the possibility that a different mechanism is pursued in maximising the objective of their policy.

Aside from inflation variability, another consistent difference in variability is found in the case of the interest rate. Unconditional variances of the interest rate simulated under the current simple policy feedback rule consistently fall below those obtained under the optimal policy regime simulations for most of the five ASEAN economies. Except for the case of Singapore, the specified rules used to represent the current policy regime consistently deliver lower variability in the rate of interest. These findings provide a strong suggestion about the preference for smoothing the interest rate fluctuations of the monetary authorities in these countries. In other words, it suggests that these monetary authorities tend to prefer stability in their policy instrument, and hence, avoid overly aggressive policy responses that can lead to wild fluctuations in the policy instrument.

Findings on relatively higher variability in all of the four key variables under the current feedback rule for the case of Singapore require further discussion. At a glance, these findings may point to a conclusion that the simple policy rule employed to characterise the current conduct of monetary policy in Singapore is practically inefficient. However, there is also a possibility that the current simple rule employed in this particular case may suffer from an instrument approximation bias. The monetary policy in Singapore is primarily conducted through managing the Singapore dollar exchange rate against an undisclosed trade-weighted basket of currencies of Singapore's major trading partners and competitors. Consequently, exchange rate targeting would be the most appropriate representation of monetary policy in Singapore (for example, see discussions in Parrado, 2004; McCallum, 2006). The use of the interest rate as a proxy for the policy instrument in this case could potentially invite an approximation bias, and the simulation results for Singapore reported in Table 4 hinted at this potential issue.

In summary, simulations conducted under the current state of simple feedback rules characterising monetary policy in the five ASEAN countries produce sub-optimal welfare implications for each of the economies. From observing differences in the implied unconditional variances for four key macro-economic variables reported in Tables 3 and 4, this finding may have come about because monetary authorities in these economies may actually be optimising over a different objective function when setting up their policy.

6 Room for Improvement?

A question that naturally follows the assessment made in the previous section would concern the issue of possible room for improving the monetary policy performances. More specifically, can one identify different characterisations of the given form of simple policy feedback rule that optimises the social loss function? An obvious approach to address this question would be to find a policy feedback rule that represents a solution to the constrained problem of optimising the social loss function, while restricting the solution to the form of the simple interest reaction function given in equation (39). When this approach is applied to the problem characterised by the underlying parameter values representing each of the sample ASEAN-5 economies, the optimisation exercise suggests implausibly aggressive policy parameters for the restricted form of simple interest feedback rule (39).

The literature on this topic also recognises the particular problem encountered above. Batini et al. (2003), for example, come across a similar issue when fitting simple rules that contain an interest smoothing argument to optimise their utility-based welfare function, where interest rate variability does not appear as an explicit argument in the objective function. Note that the representative interest reaction function used for each of the sample economies in this paper, equation (39) , includes an interest rate smoothing argument. Optimising this kind of policy reaction function on a loss function that does not include an ad-hoc added interest rate variability term, like the one in equation (22), could potentially lead one to encounter the problem mentioned above. However, adding an ad-hoc interest rate variability term into the utility-based loss function contradicts the rationale for using the social loss function in assessing the policy's welfare implications. On the other hand, dropping the interest rate smoothing argument from equation (39) defies the econometric evidence that monetary authorities in the ASEAN-5 sample prefer to smooth the interest rate fluctuations.

By way of compromise on the above issues, this paper explores the possibility for the given form of a simple policy feedback rule in equation (39) to improve social welfare by searching for a set of policy parameters that could potentially bring about around 50-70 per cent relative welfare gain from the current characterisation of the simple rules.[18] In doing so, two more restrictions are added when conducting the search. First, a new set of policy parameters obtained should fall in the acceptable range of values for a simple policy rule of this kind. Second, the search is terminated once the relative gain in the metric of welfare hits the range mentioned.[19]

Given the above explanation, the resulting set of policy parameters obtained under the search exercise should not be interpreted as a set that represents an optimal simple policy feedback rule for the problem at hand. Rather, the resulting set of policy parameters can only be construed as an example for the possible candidates from a set that delivers better welfare outcomes. The objective of this exercise is merely to provide examples of room for possible improvements that can be explored if monetary policy is to be conducted to target better welfare implications. Two examples are presented in what follows. Both examples retain the argument on the monetary authority preference over interest rate (policy instrument) stability, as well as all the relevant assumptions used in the simulations conducted previously in this paper.

6.1 Example 1: Altering all policy parameters

This example restricts the setting of monetary policy in each of the five ASEAN economies to follow an interest rate feedback rule presented by equation (39). The set of estimated policy parameters (κ_1, κ_2 and ρ_i) reported in Table 1 are not assumed to be an optimal representation of the policy maker's preference, and are hence flexible to change. The estimated policy parameters, however, is taken as the representative of the current policy regime. Therefore, these parameters are used as the starting values to initiate the search. Table 5 presents the outcome of this exercise.

[18] This range of potential welfare improvement is taken since (as shown in the following) the resulting policy parameters still fall on some sensible range of values. In this exercise, the sensible range for the policy parameters are set to be $0 < \kappa_1 < 10$, $\kappa_2 > 0$ and $0 < \rho_i < 1$.

[19] The search is conducted using the Nelder-Mead simplex direct search algorithm (see Lagarias et al., 1998, for a detailed explanation) contained in fminsearch routine in MATLAB, and truncated once the

Table 5: Welfare implications of altering all policy parameters

	Indonesia	Malaysia	The Philippines	Singapore	Thailand
100 x Loss	0.2000	0.090	0.0333	0.8699	0.0129
Welfare gain	0.6637	0.6084	0.6144	0.5605	0.0952
Policy parameters:					
κ_1	2.7813	2.0750	1.4703	1.3970	3.1211
κ_2	0.3744	0.1140	0.6650	0.8444	−0.0001
ρ_i	0.7488	0.8280	0.7904	0.9378	0.6883
Unconditional variances:					
π	0.0022	0.0010	0.0004	0.0132	0.0001
y	0.0152	0.0355	0.0011	0.0182	0.1071
q	0.1736	0.0220	0.0173	0.0037	0.2267
i	0.0084	0.0009	0.0006	0.0121	0.0008

Table 5 shows that in four out of the five ASEAN countries, the exercise conducted under the above assumptions can comfortably deliver alternative values for the policy parameters, which produce around a 55 to 70 per cent gain in welfare relative to that achieved under the current estimated policy rules. Thailand's case, however, comes out as an exception. Implausibly, to get about 10 per cent relative gain in welfare, the policy instrument has to react negatively to a positive development in the output gap. This possibly happens because of the starting value for the parameter that governs the interest rate reactions to the output gap (κ_2) being zero in the case of Thailand.

The outcomes for all the countries in this example share general common features. To improve its social welfare implications, the feedback rule needs to become more aggressive in responding to developments in inflation expectation, but less aggressive to developments in the output gap. On top of that, this welfare improving simple feedback rule is also characterised by more policy persistence (higher values for ρ_i) in all cases. Although it tends to be welfare improving, this better policy characterisation does not come without cost. This better policy characterisation manages to bring about more stable inflation and interest rate only at the cost of relatively more volatility in the output gap and the real exchange rate.

6.2 Example 2: Keeping the degree of interest persistence

This example is conducted under the same assumptions imposed in Example 1. It differs only in the treatment of an interest rate smoothing term in the simple feedback rule. In this example, the interest rate partial adjustment coefficient (ρ_i) reported in Table 1 is taken as optimally representing the preference of the policy maker. Consequently, the value of this parameter for each of the ASEAN-5 economies is kept constant according the estimated value reported in Table 1. That is, only the values for κ_1 and κ_2 are altered in order to search for a better welfare outcome. The outcome of the exercise under the assumption imposed in this second example is reported in Table 6.

As is also the case in Example 1, the exercise conducted under the assumption imposed in this example delivers alternative values for the set of policy parameters that yield a 60 to 70 per cent welfare improvement relative to the base case of the estimated set of policy parameters. Again, Thailand's case turns out to be an outlier. Although the feedback rule in the latter case does not have to be reacting negatively towards the output gap developments in this example, the policy instrument has to react implausibly aggressively

boundaries for the additional restrictions are hit.

Table 6: Welfare implications of policy alteration with fixed instrument persistence

	Indonesia	Malaysia	The Philippines	Singapore	Thailand
100 x Loss	0.2117	0.0850	0.0280	0.6624	0.0121
Welfare gain	0.6386	0.6347	0.6758	0.6654	0.1489
Policy parameters:					
κ_1	2.7979	2.1476	1.7780	1.4676	3.4284
κ_2	0.4290	0.1188	0.7016	0.7599	0.0007
ρ_i	0.5200	0.6900	0.5456	0.8525	0.7000
Unconditional variances:					
π	0.0024	0.0009	0.0003	0.0103	0.0001
y	0.0124	0.0321	0.0007	0.0086	0.1061
q	0.1607	0.0238	0.0155	0.0021	0.2270
i	0.0099	0.0015	0.0007	0.0100	0.0008

to developments in inflation expectation in order to get a more than 15 per cent gain in welfare.

The common general features on the direction of changes in the way the policy instrument should react to developments in inflation expectations and the output gap to produce better welfare outcomes in Example 1, also hold in this example. That is, in order to deliver better welfare outcomes, the policy is required to be more aggressive to developments in inflation expectation and the other way around in the case of the output gap. However, the costs for bringing more stable inflation and interest rate found in Example 1 only hold true for the cases of Indonesia, Malaysia and the Philippines in this example. In this example, the relatively more stable inflation and interest rates for the case of Singapore turn out to be accompanied by a marginally more stable output gap and real exchange rate.

6.3 A note on the examples

To an extent, the two examples above provide a picture of the existence of scope for improving the welfare outcome of monetary policy for each of the ASEAN-5 countries. This possible improvement can be achieved even by constraining the simple feedback rule to take the same Taylor-type policy rule that approximates the current monetary policy regime in these countries. Generally, both examples share common features in terms of the directional change in the main policy parameters (κ_1 and κ_2). There are, however, a few particular cases that deserve some further notes.

The Philippines case shares the main common features with most of the other cases. However, unlike the other cases, the Philippines case starts with a set of policy parameters that does not adhere to the Taylor principle. Both Examples 1 and 2 suggest that the welfare outcome in the case of the Philippines can be improved by switching its monetary policy regime to one that pays more attention to developments in inflation expectation rather than to the output gap; i.e. a regime that adheres to the Taylor principle.

Thailand is an outlier in both examples. This problem may arise due to the fact that the baseline representative regime in this case is only putting attention on the expected inflation developments to guide the direction of change in its policy stance. The trend appearing within the examples explored in this section suggests that to improve the welfare outcome, the feedback rule needs to become more aggressive in responding to developments in inflation expectation, but less aggressive towards the developments in the output gap. In this particular case, there is practically no room for reducing the weight on output gap developments. Moreover, since the starting value for κ_1 has already been relatively high in this particular case, the policy instrument often has to react implausibly aggressively to developments in inflation expectation in order to force in more stability to the already relatively stable inflation. Therefore, given the acceptable values for policy parameters, the room for obtaining a relatively large welfare gain under the exercises set out in Example 1 and 2 in the case of Thailand is very limited.

Lastly, the case of Singapore in Example 2 also brings up an interesting observation. If one is to keep the magnitude of the interest rate adjustment coefficient in the feedback rule (ρ_i) at its estimated value, then this example shows that there exist some better set of policy parameters, which both improves the welfare outcome and delivers better stability for the economy in general.

7 Concluding Remarks

The discussion provided in this paper has been focusing on the particular form of an aggregate social loss function that is derived from a utility-based welfare criterion. Comparisons of the resulting unconditional variability in the four key macro-economic variables reported in Tables 3, 4, 5 and 6, however, hint at the possibility that monetary authorities in each of the ASEAN-5 countries may have some other considerations when setting up their policy. Particularly for the cases of Indonesia, Malaysia and the Philippines, lower output gap variability obtained under the simple policy rule suggests that the monetary authorities in these countries may put larger weight on output gap variability relative to the weight employed in the social welfare criterion derived in this paper. For the former two cases, it is also shown that the real exchange rate turns out to be more stable under the simple policy rule.

Assuming that the monetary authorities are optimising their particular objective function in setting up their policy, the above findings suggest that the monetary authorities in the ASEAN-5 countries are optimising against different form of objectives. This argument is, at least, reflected in the way interest rate variability behaves under the simple rules. It is very likely that when setting up their policy, the monetary authorities in the countries considered in here prefer to smooth the profile of their policy instrument. Therefore, the likely policy maker's objective function may take an ad-hoc form that puts relatively more weight on the output gap and includes the interest rate and real exchange rate variability arguments in it.[20]

The analysis in this paper, however, refrains from looking at the likely functional form for the objective function of these monetary authorities. Instead, it focuses on analysing the impact of monetary policy on the utility-based welfare criterion for each of the ASEAN-5 economies. Consistent with the literature, the results suggest that these countries will be better-off if they conduct their monetary policy under a commitment rather than under a discretionary regime. Furthermore, by assuming that the current policy regime is represented by the estimated policy reaction functions for each of the economies, the results suggest that scope for improving the performance of monetary policy in these countries exists. By way of example, it is also shown that improving the efficiency in the performance of monetary policy is also possible even when keeping the particular form of the policy rule. This improvement can be achieved by altering the feedback parameters within the rule.

[20] The variant of ad-hoc types of objective function are commonly used for analysing monetary policy in the literature. Some go even further by estimating the weight for the arguments appearing in this type of ad-hoc form of objective function from the economic outcome; e.g. Dennis (2004a, 2006). This latter approach is taken under the assumption that the policy maker's optimising behaviour is reflected in the equilibrium relationship between policy instruments and the state variables in the representative system of the economy.

Some notes, however, need to be provided in interpreting the above assessment on the possible improvement for conducting monetary policy. Especially for the case of Indonesia, Malaysia and the Philippines, improvement in welfare discussed in Examples 1 and 2 implies higher variability in the measure of output gap as well as the real exchange rate. If it turns out that the monetary authorities in these countries target both (or at least one) of those two variables by weighing them heavily in their institutional objective functions, then promoting a policy arrangement that improves welfare can become problematic.

Nonetheless, as the scope for improving monetary policy is open to the ASEAN-5 economies under consideration, exploration of possible alternatives for improvement becomes a natural topic for future extension of the analysis provided in this paper. A possible alternative for extension would be to see how a battery of different simple monetary policy rules can contribute towards narrowing the distance between the welfare implications of these rules relative to the welfare implications of fully optimal monetary policy regimes. Another equally interesting alternative to be explored is to see if having some sort of monetary cooperation among the ASEAN-5 countries involved could help in improving the welfare outcome.

The latter alternative mentioned above appears to be an attractive way to extend the analysis of this paper for several reasons. First of all, the issue has been floated since the Asian crisis in 1997.[21] Economic interconnections among the ASEAN-5 countries considered have also been growing and increasing at a faster rate lately. Further, as shown in the discussions in this paper, monetary policy that is conducted based on a commitment regime tends to produce superior welfare outcomes relative to the one that is based on a discretionary regime. In practice, however, it is often difficult to implement a credible commitment regime. Having formal policy coordination within the region has the potential to help in promoting the commitment technology to gain more credibility for each of the monetary authorities involved. Therefore, it may potentially help in delivering more efficient welfare outcomes in the conduct of monetary policy.

[21] The issue of currency cooperation in ASEAN has actually been included as one of the four pillars of the ASEAN roadmap for financial and monetary integration. (See the ASEAN fact sheet, 16^{th} of April 2007; available at http://www.aseansec.org/Fact%20Sheet/AEC/2007-AEC-009.pdf)

References

BACKUS, D. AND J. DRIFFILL (1986): "The Consistency of Optimal Policy in Stochastic Rational Expectations Models," CEPR Discussion Papers 124, C.E.P.R. Discussion Papers.

BARRO, R. J. AND D. B. GORDON (1983): "Rules, Discretion and Reputation in a Model of Monetary Policy," *Journal of Monetary Economics*, 12, 101–121.

BATINI, N., R. HARRISON, AND S. P. MILLARD (2003): "Monetary Policy Rules for an Open Economy," *Journal of Economic Dynamics and Control*, 27, 2059–2094.

BENIGNO, P. AND M. WOODFORD (2006a): "Linear-Quadratic Approximation of Optimal Policy Problems," NBER Working Papers 12672, National Bureau of Economic Research, Inc.

——— (2006b): "Optimal Taxation in an RBC Model: A Linear-Quadratic Approach," *Journal of Economic Dynamics and Control*, 30, 1445–1489.

BINDER, M. AND M. PESARAN (1995): "Multivariate Rational Expectations Models and Macroeconometric Modeling: A Review and Some New Results," in *Handbook of Applied Econometrics: Macroeconomics*, ed. by M. Pesaran and M. Wickens, Blackwell Publishers, vol. 1, chap. 3, 139–187.

CALVO, G. A. (1983): "Staggered Prices in a Utility-Maximizing Framework," *Journal of Monetary Economics*, 12, 383–398.

CECCHETTI, S. G., A. FLORES-LAGUNES, AND S. KRAUSE (2006): "Has Monetary Policy Become Bore Efficient? A Cross-Country Analysis," *Economic Journal*, 116, 408–433.

CHRISTIANO, L. J. (2002): "Solving Dynamic Equilibrium Models by a Method of Undetermined Coefficients," *Computational Economics*, 20, 21–55.

CLARIDA, R., J. GALI, AND M. GERTLER (1999): "The Science of Monetary Policy: A New Keynesian Perspective," *Journal of Economic Literature*, 37, 1661–1707.

DE BROUWER, G. AND J. O'REGAN (1997): "Evaluating Simple Monetary Policy Rules for Australia," in *Monetary Policy and Inflation Targeting*, ed. by P. Lowe, Proceedings of a Conference, Reserve Bank of Australia, 244–76.

DENNIS, R. (2004a): "Inferring Policy Objectives from Economic Outcomes," *Oxford Bulletin of Economics and Statistics*, 66, 735–764.

——— (2004b): "Solving for Optimal Simple Rules in Rational Expectations Models," *Journal of Economic Dynamics and Control*, 28, 1635–1660.

——— (2006): "The Policy Preferences of the US Federal Reserve," *Journal of Applied Econometrics*, 21, 55–77.

——— (2007): "Optimal Policy In Rational Expectations Models: New Solution Algorithms," *Macroeconomic Dynamics*, 11, 31–55.

DENNIS, R. AND U. SODERSTROM (2006): "How Important Is Precommitment for Monetary Policy?" *Journal of Money, Credit and Banking*, 38, 847–872.

DIXIT, A. K. AND J. E. STIGLITZ (1977): "Monopolistic Competition and Optimum Product Diversity," *American Economic Review*, 67, 297–308.

DOCKNER, E., N. VAN LONG, S. JORGENSEN, AND G. SORGER (2000): *Differential Games in Economics and Management Science*, Cambridge University Press.

EDGE, R. M. (2003): "A Utility-Based Welfare Criterion in a Model with Endogenous Capital Accumulation," Finance and Economics Discussion Series 2003-66, Board of Governors of the Federal Reserve System (U.S.).

ERCEG, C. J., D. W. HENDERSON, AND A. T. LEVIN (2000): "Optimal Monetary Policy with Staggered Wage and Price Contracts," *Journal of Monetary Economics*, 46, 281–313.

FUHRER, J. C. (1997): "Inflation/Output Variance Trade-offs and Optimal Monetary Policy," *Journal of Money, Credit and Banking*, 29, 214–34.

FUHRER, J. C. AND G. MOORE (1995): "Inflation Persistence," *The Quarterly Journal of Economics*, 110, 127–59.

GALI, J. AND T. MONACELLI (2005): "Monetary Policy and Exchange Rate Volatility in a Small Open Economy," *Review of Economic Studies*, 72, 707–734.

HANSEN, L. AND T. SARGENT (1998): *Recursive Models of Dynamic Linear Economies*, manuscript, University of Chicago.

JENSEN, H. (2002): "Targeting Nominal Income Growth or Inflation?" *American Economic Review*, 92, 928–956.

KYDLAND, F. E. AND E. C. PRESCOTT (1977): "Rules Rather Than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy*, 85, 473–91.

LAGARIAS, J., J. REEDS, M. WRIGHT, AND P. WRIGHT (1998): "Convergence Properties of the Nelder–Mead Simplex Method in Low Dimensions," *SIAM Journal on Optimization*, 9, 112–147.

MCCALLUM, B. T. (1998): "Solutions to Linear Rational Expectations Models: A Compact Exposition," *Economics Letters*, 61, 143–147.

——— (2006): "Singapore's Exchange Rate-Centered Monetary Policy Regime and its Relevance for China," MAS Staff Paper 43, Monetary Authority of Singapore.

ORPHANIDES, A. AND V. WIELAND (2000): "Inflation Zone Targeting," *European Economic Review*, 44, 1351–1387.

PAPPA, E. (2004): "Do the ECB and the Fed Really Need to Cooperate? Optimal Monetary Policy in a Two-Country World," *Journal of Monetary Economics*, 51, 753–779.

PARRADO, E. (2004): "Singapore's Unique Monetary Policy: How Does it Work?" IMF Working Papers WP/04/10, International Monetary Funds.

RAMAYANDI, A. (2008): "Simple Model for a Small Open Economy: An Application to the ASEAN-5 Countries," Working Papers in Economics and Development Studies (WoPEDS) 200801, Department of Economics, Padjadjaran University.

ROTEMBERG, J. J. AND M. WOODFORD (1998): "An Optimization-Based Econometric Framework for the Evaluation of Monetary Policy: Expanded Version," NBER Technical Working Papers 0233, National Bureau of Economic Research, Inc.

SODERLIND, P. (1999): "Solution and Estimation of RE Macromodels with Optimal Policy," *European Economic Review*, 43, 813–823.

SVENSSON, L. E. O. (1999): "Inflation Targeting as a Monetary Policy Rule," *Journal of Monetary Economics*, 43, 607–654.

——— (2000): "Open-Economy Inflation Targeting," *Journal of International Economics*, 50, 155–183.

——— (2003): "What is Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules," *Journal of Economic Literature*, 41, 426–477.

Taylor, J. B. (1993): "Discretion Versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy*, 39, 195–214.

Uhlig, H. (1999): "A Toolkit for Analyzing Nonlinear Dynamic Stochastic Models Easily," in *Computational Methods for the Study of Dynamic Economies*, ed. by R. Marimon and A. Scott, Oxford University Press, 30–61.

Walsh, C. E. (2003): *Monetary Theory and Policy*, Cambridge and London: MIT Press., second ed.

Woodford, M. (2003): *Interest and Prices*, Princeton and Oxford: Princeton University Press.

APPENDIX

Summary of the dynamic constraint:

1. CPI Inflation:

$$\pi_t = \frac{1}{1+\beta\delta}\left[\beta E_t\left(\pi_{t+1}\right) + \delta\pi_{t-1} + (1-\alpha)\,\Gamma_D mc_t + \alpha\Gamma_F\psi_t\right]$$

2. Marginal cost equation:

$$mc_t = \varphi y_t + \frac{\sigma}{1-h}\left(c_t - hc_{t-1}\right) + \frac{\alpha}{1-\alpha}\left(q_t - \psi_t\right) - (1+\varphi)\,b_t$$

3. Euler equation for consumption:

$$\left(c_t - hc_{t-1}\right) = E_t\left(c_{t+1} - hc_t\right) - \frac{(1-h)}{\sigma}\left(i_t - E_t\pi_{t+1}\right) + \upsilon_t^c$$

4. Goods market clearing condition:

$$y_t = (1-\alpha)\,c_t + \alpha y_t^* + \frac{\alpha\,(2-\alpha)\,\eta}{(1-\alpha)}q_t - \frac{\alpha\eta}{(1-\alpha)}\psi_t$$

5. International consumption risk sharing condition:

$$\frac{(1-h)}{\sigma}q_t = \left(c_t - hc_{t-1}\right) - \left(y_t^* - hy_{t-1}^*\right) + \upsilon_t^q$$

6. Domestic aggregate productivity:

$$b_t = \rho_b b_{t-1} + \upsilon_t^b$$

7. Deviation of the law of one price:

$$\psi_t = \rho_\psi\psi_{t-1} + \upsilon_t^\psi$$

8. External block:

$$y_t^* = \phi_1 y_{t-1}^* + \phi_2\left(i_{t-1}^* - E_t\pi_t^*\right) + \upsilon_t^{y^*}$$

$$\left(i_t^* - E_t\pi_{t+1}^*\right) = \phi_3 y_{t-1}^* + \phi_4\left(i_{t-1}^* - E_t\pi_t^*\right) + \upsilon_t^{r^*}$$

9. Interest reaction function:

$$i_t = (1-\rho_i)\left(\kappa_1 E_t\pi_{t+n} + \kappa_2 y_t\right) + \rho_i i_{t-1} + \upsilon_t^i$$